GLOBAL ACADEMIC RESEARCH INSTITUTE

COLOMBO, SRI LANKA

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CASE STUDY ON RECESSION AND ITS IMPACT ON TELECOMMUNICATIONS INDUSTRY

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ABSTRACT

Telecommunications industry is stepping into most challenging era since its inception due to the complexity derived out of economic, political, social technological developments of aspects of modern world. Most of the markets expect to be stagnated. APAC region forecasts around 2% flat revenue growth till year 2025 (GSMA, 2022). In such time, Sri Lanka is currently facing an economic crisis with major economic indicators worsening on quarterly basis, indicating the worst economic situation after independence. The purpose of the study was to differentiate natural industry behavior of telecommunication Key Performance Indicators (KPIs) compared to behavior during a downturn, especially a recession. Furthermore, this study focuses post-recession behavior of major telco KPIs and its relationship with economic KPIs to find applicability of outcomes to current Sri Lankan economic context while identifying threats and opportunities lies within next few years for the telecommunications business. The study has been conducted using historical KPI data obtained from 36 countries, 144 mobile operators over a 22-year span to identify recession periods and statistically analyze post-recession behaviors of KPIs. Hypothesis testing, correlation and regression analysis has been used to derive key outcomes of this study. Moreover, the study has been further extended to identify top and worst performed operators to analyze strategic actions taken during recession periods.

The study yields several key findings including high significance of correlation between mobile connection and mobile revenue growth rates, percentage of mobile operators with 10% revenue drop after one and two years from recession and regression analysis shows high degree of significance between revenue growth with mobile connections, average revenue per user (ARPU) and inflation growth rates. Furthermore, the study explains how actively top and worst performed operators have participated in merges and acquisitions, new solution offerings, spectrum acquisitions and network collaborations.

Key words: Recession, Telecommunications, Revenue growth, Correlation, Hypothesis

INTRODUCTION

Recession is defined as a significant decline in economic activity measured by GDP that lasts for months or even years complemented by high inflation, local currency depreciation and high unemployment rate (Rodeck, 2022). By its definition, a country is said to be in a recession when its economy experiences negative GDP growth in two consecutive quarters with positive evidence in other complementary factors. Following figures elaborates negative GDP growth stages of Greece and Sri Lanka during specified periods. Sri Lankas GDP is expected to fall by 4.3% in 2023 (World Bank Group, 2022) further illustrates ongoing economic crisis of the country and risks involved with it.
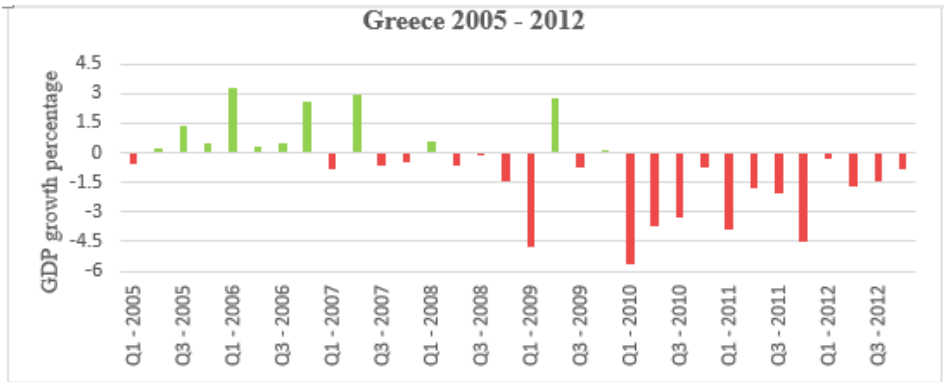
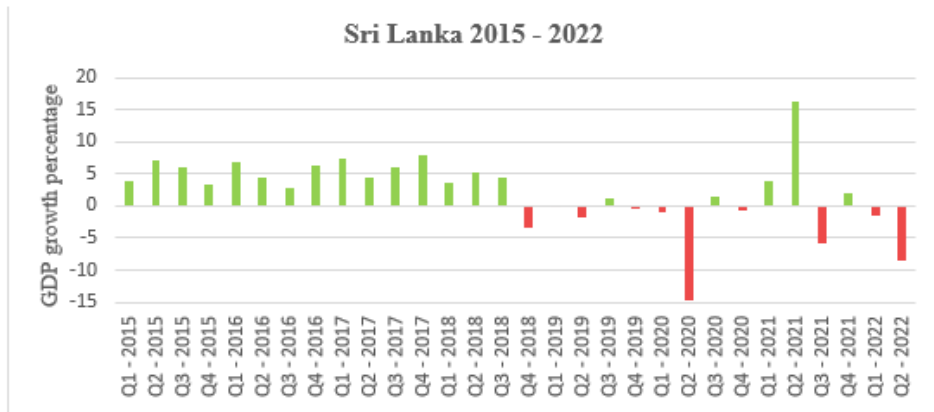Figure 1 - Quarterly GDP growth of Greece (OECD, 2022)

Figure 2 - Quarterly GDP growth of Sri Lanka (Central Bank Sri lanka, 2022)

METHODOLOGY

The study has been conducted under five main stages to statistically analyze the relationships between telco KPIs (revenue, connections & ARPU) and economic KPIs (inflation, unemployment & exchange rate) by considering relevant pre- and post-recession growth figures. Following data sets and KPIs were used to conduct the analysis

Figure 3 - Data sets and KPIs used for the analysis

i. Collection of data

a.   Operator wise telco KPIs – Revenue, connections & ARPU

b.   Country wise economic KPIs – GDP, inflation, forex rates and unemployment

ii.   Compilation of data

a.   Aggregation of country wise telco and economic data

b.   Data cleaning process

iii.   Statistical analysis of the data set

a.   Hypothesis testing on post-recession revenue and connection

b.   Correlation between telco KPIs

c. Correlation between telco and economic KPIs

d. Regression analysis for revenue growth

iv. Ranking of mobile operators

a. Calculate weighted score based on telco KPIs

b. Rank operators based on the score

v. Outlier analysis

a. Analyzing successive actions within three years of recession

b. Correlation analysis of top and worst performed 20 operators

c. Regression analysis of top and worst performed 20 operators

Data collection and compilation

Data collection for the analysis has been done using three main sources.

i. Annual figures of Telco KPIs for 733 mobile operators in 195 countries for last 22 years (2000 – 2021) (GSMA, 2022)

a. Total mobile revenue

b. Total mobile connections

c. Average revenue per user (ARPU)

ii. Annual figures of economic KPIs for 195 countries for last 22 years (The World Bank, 2022)

a. GDP (Local currency)

b. Inflation, consumer prices (annual %)

c. Official exchange rate (LCU per USD)

d. Unemployment (% of total labor force) (national estimate)

iii. Quarterly GDP growth rate figures of 36 countries (OECD, 2022)

All relevant telco and economic KPIs has been collected from above mentioned 1st and 2nd sources for 195 countries with only exception of "Quarterly GDP growth rate" which was required to mathematically identify Recession periods of each country. With reference to The Organization for Economic Co-operation and Development (OECD), quarterly GDP rates for- 36 countries over 22-year span was obtained to proceed with the case study. Moreover, all the major indicators have been converted to growth rates comparing relevant pre- and post-recession years to overcome the dependency from different local currencies. An analytical model has been developed using above data to identify recession periods of the 36 countries in line with the definition of recession. The model further extended to a graphical interface to visualize recession periods of each country on top of telco KPIs of each operator. This analytical model elaborates how major telco KPIs have historically behaved during pre- and post-recession periods of selected 36 countries.

Following is an example showing total mobile revenue behavior of operators top two mobile operators in Greece and Croatia during recession periods (Only top two mobile operators of both countries based on local market share is shown in graphs)
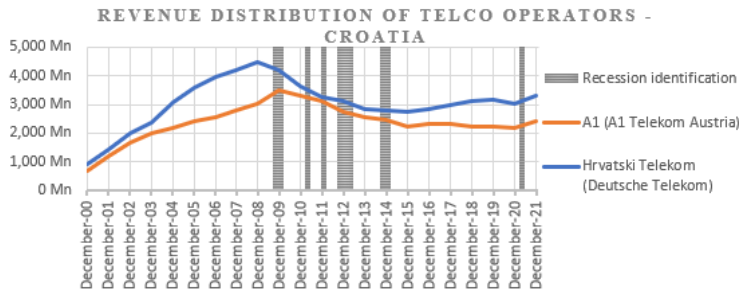
REVENUE DISTRIBUTION OF TELCO OPERATORS - CROATIA

Figure 4 - Revenue distribution of telco operators in Croatia during recession

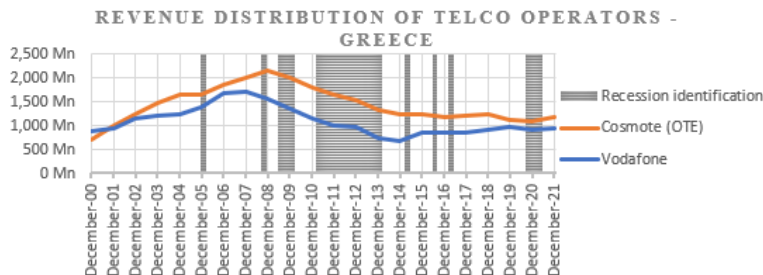REVENUE DISTRIBUTION OF TELCO OPERATORS - GREECE

Figure 5 - Revenue distribution of telco operators in Greece during recession

Statistical Analysis

A statistical analysis of the data set has been conducted under three main areas to understand post-recession behavior of main telco KPIs and its relationship with economic KPIs.

i.   Hypothesis testing to interpret post-recession revenue and connection growth rates of telco operators

ii.   Correlation analysis to identify significance of correlation between Telco KPIs and economic KPIs

iii.   Regression analysis to identify how revenue growth is affected by other independent telco and economic variables

Hypothesis testing

A hypothesis testing is an act of statistics to test an assumption based on a population parameter (MAJASKI, 2021). In this study hypothesis tests were conducted to statistically verify revenue and connection growth related factors to determine post-recession behavior of these KPIs. Below methodology has been

adopted as the standard process for statistical hypothesis testing

i.   State null hypothesis (Ho) and alternative hypothesis (Ha)

ii.   Extract & derive relevant figures from raw data set to test hypothesis

iii.   Perform appropriate statistical test

o   Z Statistic has been used in this study as sample size, n > 30 for all testing cases.

Equation (1)

$$Z = \frac{\hat{p} - p}{\sqrt{\dfrac{p.(1-p)}{n}}}$$

p - probability of success
$\hat{p}$ - proportion of success in the sample
n - sample size

iv. Decide whether to reject or fail to reject null hypothesis (Ho)

o95% confidence interval has been used decide result of null hypothesis

Revenue growth related hypothesis & results

To derive revenue growth figures, revenues comparing pre-recession year and required post-recession years for all 144 operators has been considered. Hypothesis testing has been done for revenue growth taking below factors as null hypothesis.

Table 1 - Hypothesis results for post-recession revenue growth

No	Hypothesis (Ho)	Ho	Ha	Result
1	More than 15% of the mobile operators suffer more than 20% revenue drop after first year from recession	>= 0.15	<0.15	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
2	More than 20% of the mobile operators suffer more than 20% revenue drop after first year from recession	>=0.2	<0.2	Z stat fall under rejection region; with 95% confidence null hypothesis can be rejected
3	More than 25% of the mobile operators suffer more than 20% revenue drop after two years from recession	>=0.25	<0.25	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
4	More than 30% of the mobile operators suffer more than 20% revenue drop after two years from recession	>=0.3	<0.3	Z stat fall under rejection region; with 95% confidence null hypothesis can be rejected
5	More than 35% of the mobile operators suffer more than 10% revenue drop after first year from recession	>=0.35	<0.35	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
6	More than 40% of the mobile operators suffer more than 10% revenue drop after first year from recession	>=0.4	<0.4	Z stat fall under rejection region; with 95% confidence null hypothesis can be rejected
7	More than 40% of the mobile operators suffer more than 10% revenue drop after two years from recession	>=0.4	<0.4	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
8	More than 50% of the mobile operators suffer more than 10% revenue drop	>=0.5	<0.5	Z stat fall under rejection region; with 95% confidence null hypothesis can be rejected

No	Hypothesis (Ho)	Ho	Ha	Result
	after two years from recession			
9	More than 96% operators with negative revenue growth after first year compared to prerecession year, failed to breakeven their revenue even in the following year	>=0.96	<0.96	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
10	More than 92% operators with negative revenue growth after two years compared to precession year, failed to breakeven their revenue even in the following year	>=0.92	<0.92	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
11	More than 95% operators with negative revenue growth after three years compared to prerecession year, failed to breakeven their revenue even in the following year	>=0.95	<0.95	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected

Connection growth related hypothesis & results

To derive connection growth figures, total mobile connections comparing pre-recession year and required post-recession years for all 144 operators has been considered. Hypothesis testing has been done for connection growth taking below factors as null hypothesis.

Table 2 - Hypothesis results for post-recession mobile connection growth

No	Hypothesis (Ho)	Ho	Ha	Result
1	More than 15% of the mobile operators suffer more than 10% mobile connection drop after first year from recession	>=0.15	<0.15	Z stat does not fall under rejection region; with 95% confidence null hypothesis can't be rejected
2	More than 25% of the mobile operators suffer more than 10% mobile connection drop after first year from recession	>=0.25	<0.25	Z stat fall under rejection region; with 95% confidence null hypothesis can be rejected
3	More than 15% of the mobile operators suffer more than 10% mobile	>=0.15	<0.15	Z stat does not fall under rejection region; with 95%

	connection drop after two years from recession			confidence null hypothesis can't be rejected
4	More than 25% of the mobile operators suffer more than 10% mobile connection drop after two years from recession	>=0.25	<0.25	Z stat fall under rejection region; with 95% confidence null hypothesis can be rejected

Interpretation of hypothesis results

Below important facts can be summarized from the hypothesis testing analysis.

i.   A minimum of 20% revenue drop is observed in more than 15% of Mobile operators after first year from recession (which is 25% of mobile operators after 2 years)

ii.   A minimum of 10% revenue drop is observed in more than 35% of Mobile operators after first year from recession (which is 40% of mobile operators after 2 years).

iii.   A minimum of 10% connection drop is observed in more than 15% of the mobile operators after first year from recession (which is also 15% of mobile operators after 2 years).

iv.   More than 96% operators with negative revenue growth after 1 year compared to precession year, failed to reach their pre-recession revenue even in the following year.

v.   More than 92% operators with negative revenue growth after 2 years compared to precession year, failed to reach their pre-recession revenue even in the following year.

vi.   More than 95% operators with negative revenue growth after 3 years compared to precession year, failed to reach their pre-recession revenue even in the following year.

Correlation analysis

The correlation coefficient (r) is a measure that determines the degree to which the movement of two variables is associated. The most common correlation coefficient, generated by the Pearson product-moment correlation, is used to measure the linear relationship between two variables (Nickolas, 2021).

Equation (2)
$$r = \frac{\sum(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum(x_i - \overline{x})^2(y_i - \overline{y})^2}}$$

r – correlation coefficient
x_i – values of x-variable in a sample
$\overline{x}$ - mean of the values of x-variable
y_i – values of y-variable in a sample
$\overline{y}$ - mean of the values of y-variable

Correlation analysis of the variables (revenue, connections, ARPU, inflation, currency depreciation, unemployment growth figures) has been done under three main categories,

i.   Growth rates derived comparing prerecession year figures to 2 years post-recession figures for all variables (T0 analysis)

ii.   Growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession year figures to 1-year post-recession figures (T-1 analysis)

iii.   Growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to recession year figures (T-2 analysis)

Correlation analysis for 144 operators (T0 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering all 144 operators (n=144) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for all variables

Table 3 - Correlation analysis for 144 operators (T0 analysis)

	Revenue	Connections	ARPU
Revenue	1		
Connections	0.52	1	
ARPU	0.25	-0.28	1
Inflation	-0.09	0.21	0.08
Currency Dep^n	-0.07	0.09	0.21
Unemployment	-0.22	-0.21	-0.08

The correlation analysis shows that a significant positive correlation (r=0.52) is observed between revenue and connections growth rates. However, there is no significant relationship is observed between other economic KPIs and telco KPIs.

Correlation analysis for 144 operators (T-1 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering all 144 operators (n=144) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to 1-year post-recession figures.

Table 4 - Correlation analysis for 144 operators (T-1 analysis)

	Revenue $_{t=0}$	Connections $_{t=t-1}$	ARPU $_{t=t-1}$
Revenue $_{t=0}$	1		
Connections $_{t=t-1}$	0.55	1	
ARPU $_{t=t-1}$	0.25	-0.26	1
Inflation $_{t=t-1}$	0.01	-0.08	0.26
Currency Dep^n $_{t=t-1}$	-0.01	0.05	0.13
Unemployment $_{t=t-1}$	-0.19	-0.22	0.10

The correlation analysis shows that a significant positive correlation (r=0.55) is observed between revenue and connections growth rates. However, there is no significant relationship is observed between other economic KPIs and telco KPIs.

Correlation analysis for 144 operators (T-2 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering all 144 operators (n=144) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to recession year figures.

Table 5 - Correlation analysis for 144 operators (T-2 analysis)

	Revenue $_{t=0}$	Connections $_{t=t-2}$	ARPU $_{t=t-2}$
Revenue $_{t=0}$	1		
Connections $_{t=t-2}$	0.40	1	
ARPU $_{t=t-2}$	0.23	-0.10	1
Inflation $_{t=t-2}$	0.00	-0.09	0.18
Currency Dep^n $_{t=t-2}$	0.06	-0.15	0.14
Unemployment $_{t=t-2}$	-0.17	-0.29	0.08

The correlation analysis shows that a positive correlation (r=0.40) is observed between revenue and connections growth rates. However, there is no significant relationship is observed between other economic KPIs and telco KPIs.

Regression analysis

Regression analysis is a powerful tool for uncovering the associations between variables observed in data. It is a statistical method that attempts to determine the strength and character of the relationship between one dependent variable (usually denoted by Y) and a series of other variables (known as independent variables) (Beers, 2022).

Equation (3)
$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \ldots + b_nX_n$$

Y – dependent variable
X_n – independent variable(s)
a - Y axis intercept
b_n – coefficient of independent variable(s)

In this case study, regression analysis for revenue growth has been conducted to identify the significance of impact from other variables (connections, ARPU, inflation, currency depreciation & unemployment growth figures). The analysis has been by taking growth rates for all 144 operators comparing prerecession figures to 2 years after post-recession figures for all variables.

Results of the regression analysis (144 operators)

Following regression model was obtained through a multiple linear regression analysis taking all 144 operator growth figures as the sample.

Equation (4)

$$R = 0.71C + 0.64A - 2.16I - 0.06D - 0.86U + 0.05$$

R - Revenue growth
C - Connection growth
A - ARPU growth
I - Inflation growth
D - Depreciation growth
U - Unemployment growth

Table 1 - Regression statistics (144 operators)

Regression Statistics	
R Square	0.50
Standard Error	0.23
Observations	144

Table 2 - Regression coefficients (144 operators)

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.05	0.03	1.46	0.15
Connections	0.71	0.07	10.61	0.00
ARPU	0.64	0.09	7.16	0.00
Inflation	-2.16	0.73	-2.95	0.00
Currency Dep^n	-0.06	0.11	-0.52	0.60
Unemployment	-0.86	0.54	-1.59	0.11

The P value of currency depreciation and unemployment growth figures are higher than 0.05, which emphasize the fact that these variables are statistically insignificant for the regression model. Based on the significance of independent variables regression analysis has been repeated to increase the goodness of fit of the model.

Equation (5)

$$R = 0.73C + 0.65A - 2.27I + 0.01$$

Table 3 - Improved regression statistics (144 operators)

Regression Statistics	
R Square	0.50
Standard Error	0.23
Observations	144

Table 9 - Modified regression coefficients (144 operators)

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.01	0.02	0.36	0.72
Connections	0.73	0.07	11.12	0.00
ARPU	0.65	0.09	7.47	0.00
Inflation	-2.27	0.50	-4.53	0.00

Ranking of operators

A ranking of the 144 mobile operators was conducted to further analyze on the data set based on top and worst performers. The intention was to identify the actions taken by top and worst performed operators during post-recession periods. Below step-by-step methodology was adapted to rank operators.

i.   Setting weighted scores for telco KPIs

Table 10 - Weighted scores used for operator ranking

KPI	Score
Revenue growth	10
Connections growth	8
ARPU growth	6

ii. Calculating growth figures of revenue, connection and ARPU growth rates based on below periods

a. Growth figures comparing prerecession year and one year post recession

b. Growth figures comparing prerecession year and two years post-recession

iii. Calculating weighted scores for each operator based on above two categories

Equation (6)

$$Score = \sum \frac{(revenue\ growth * 10) +}{(connection\ growth * 8) + (ARPU\ growth * 6)}$$

iv. Calculating final score for operator based on the average

Equation (7)

Final Score=Average (Score1, Score2)

Outlier analysis

Under the outlier analysis top and worst performed operators have been analyzed to determine the actions they have taken to perform under the said categories. In this section only five mobile operators have been considered from each top and worst categories to critically analyze their key actions, whereas twenty mobile operators have been considered for all statistical analysis in upcoming sections under correlation and regression analysis for top and worst operators.

Five operators from top and worst category has been extracted from the ranking table with a condition of operators containing more than 20% local market share and less than 35% market share. The market share constraint supports to generalize the sample while excluding operators with higher and lower market shares as their key actions may supported by local market share position.

Identification of top performed operators

Below table contains top 5 performers taken from the ranking and their telco KPI growth figures compared to prerecession year with 2 years from post-recession.

Table 11 - Top performed operators based on ranking

No	Country	Recession Year	Mobile Operator	Market share 3rd Year	Local market position	Revenue growth	Connections growth	ARPU growth
1	Romania	2009	Telekom Romania (OTE)	21%	3	75%	16%	9%
2	United States	2008	Verizon Wireless	34%	1	46%	46%	-2%
3	Russia	2008	MegaFon	28%	3	29%	41%	-11%
4	Russia	2008	MTS (Sistema)	32%	1	33%	20%	2%
5	United States	2008	AT&T	31%	2	28%	18%	1%

Identification of worst performed operators

Below table contains worst 5 performers taken from the ranking and their telco KPI growth figures compared to prerecession year with 2 years from post-recession.

Table 12 - Worst performed operator details

No	Country	Recession Year	Mobile Operator	Market share 3rd Year	Local market position	Revenue	Connections	ARPU
1	Czech Republic	2012	Vodafone	27%	3	-17%	-1%	-25%
2	Greece	2010	WIND (Largo)	20%	3	-15%	-38%	32%
3	Italy	2011	TIM (Telecom Italia)	33%	2	-14%	1%	-21%
4	Spain	2011	Vodafone	30%	2	-21%	-12%	-25%
5	Greece	2010	Vodafone	31%	2	-25%	-36%	5%

Top and worst performed operator's key actions after recession

A detail study was conducted on selected top and worst operators to identify key actions taken after recession. These actions were obtained over a three-year span after recession year. Based on the collected information, actions were categorized in to five sections to further analyze how actively they have executed these actions. Following categories are selected with key industrial examples.

i.   Network expansions

Mobile operators often expand their existing radio network infrastructure to stay ahead of increasing customer demand for data and voice traffic. Below shows several examples related to network expansions from the selected top and worst sample.

In 2009, Verizon Wireless has added a twelfth regional mobile operator to its 'Long Term Evolution (LTE) in Rural America' programme, after inking an agreement with Kentucky-based Appalachian Wireless. In 2010, Mobile TeleSystems (MTS), has expanded its services to the capital of the Chechen Republic, Grozny, where it is providing comprehensive 2G coverage with limited 3G coverage in the city's main business district.

ii.   Merges and acquisitions

Many telecom organizations are turning to merges and acquisitions to add new capabilities and evolve their businesses for the next era, especially to stay resilient to adverse economic conditions. Following are key examples of such merges and acquisitions adopted by selected top performed operators during recession times.

During March 2011 AT&T agreed to acquire T-Mobile USA in a cash and stock transaction valued approximately USD 39 Bn (CBS News, 2011). In October 2009, Russia's leading mobile operator by subscribers Mobile TeleSystems (MTS) has announced that it has successfully completed the acquisition of a 50.9% stake in fixed line operator Comstar United TeleSystems from media conglomerate Sistema (Comms Update, 2009). In June 2011, MegaFon confirms USD270 million acquisition of NetByNet (Comms Update, 2011)

iii.   New solution offerings

New service or solution offerings has been a key focus of the top performed operators during recession period. The new service offerings enable Telcos to enhance their revenue streams from the usual mobile business which supports to minimize revenue drop during recession times. Several examples of new solutions offerings adopted by operators are as below. Romtelecom Business Solutions has enabled GPS satellite tracking solution starting from 1st July, 2011, any company customer can monitor their fleet of cars using this solution, thus reducing their costs and increasing their productivity level (Telekom Romania, 2011). In January 2010, AT&T, the second-largest US mobile operator and the exclusive provider of wireless service for Apple's iPhone and iPad devices, scrapped its USD 30-a-month unlimited mobile data plan and introduce tiered plans for new smartphone and iPad owners based upon data consumption (Comms Update, 2010)

iv.   Spectrum acquisitions

Spectrum relates to the radio frequency range allocated to a certain mobile operator to transfer voice and data for its customers, hence it is recognized as one of the most valuable assets for a telco operator. Any new additions to existing spectrum enhance the ability to cater more traffic with increased data speeds resulting incremental revenues. Following are several examples for spectrum

acquisitions done by operators during recession period.

In September 2009, AT&T bought 700MHz spectrum from Vulcan to support its LTE deployment plans (Comms Update, 2009). In December 2010, AT&T agreed to buy Qualcomm's 700MHz spectrum holdings for USD1.925 billion (Comms Update, 2010)

v.   Network collaborations

Network collaboration is where operators share their existing network resources with other organizations through a strategic partnership to increase revenue or reduce cost. This strategy is often observed in worst performing operators especially seeking cost reduction options during recession period.

In June 2013, Vodafone Greece and rival full-service Greek operator Wind Hellas have struck a 15-year mobile network sharing agreement to save costs (Staff, 2013). Telecom Italia (TI) and domestic power company Enel have signed an agreement to share infrastructure on their respective networks (Update, 2014)

Summary of key actions taken by top performed operators

Following table summarizes how actively top performed operators have adopted key actions (described in previous section) within 3 years span from recession year.

Table 13 - Key actions taken by top performed operators

Country	Operator	Market Share 3rd Year	Network Expansions	Mergers & Acquisitions	New Solution Offerings	Spectrum Acquisitions	Network Collaborations
Romania	Telekom Romania	21%	Actively	Moderate	Actively	Low	Low
United States	Verizon Wireless	34%	Actively	Moderate	Actively	Actively	Low
Russia	MegaFon	28%	Actively	Actively	Moderate	Low	Low
Russia	MTS (Sistema)	32%	Actively	Actively	Actively	Low	Actively
United States	AT&T	31%	Actively	Actively	Actively	Actively	Low

Summary of key actions taken by worst performed operators

Following table summarizes how differently worst performed operators have adopted same key actions within 3 years span from recession year.

Table 14 - Key actions taken by worst performed operators

Country	Operator	Market Share 3rd Year	Network Expansions	Mergers & Acquisitions	New Solution Offerings	Spectrum Acquisitions	Network Collaborations
Czech Republic	Vodafone	27%	Actively	Low	Moderate	Low	Moderate
Greece	WIND (Largo)	20%	Actively	Moderate	Moderate	Low	Actively
Italy	TIM (Telecom Italia)	33%	Actively	Low	Moderate	Low	Actively
Spain	Vodafone	30%	Actively	Moderate	Moderate	Low	Actively
Greece	Vodafone	31%	Actively	Low	Moderate	Low	Actively

With reference to above two tables, it is observed that top performers after the recession, have actively participated in mergers/acquisition, new solution offerings and spectrum acquisitions whereas worst performers after the recession, have actively participated in network collaborations among their competitors to reduce the OPEX. However, they were lacking in the areas of acquisitions, new service offerings and spectrum acquisitions.

Correlation analysis of top and worst performed operators

Correlation analysis for the top and worst performed operators has been done taking the variables of revenue, connections, ARPU, inflation, currency depreciation, unemployment growth figures under three main categories,

i. Growth rates derived comparing prerecession year figures to 2 years post-recession figures for all variables (T0 analysis)

ii. Growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession year figures to 1-year post-recession figures (T-1 analysis)

iii. Growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to recession year figures (T-2 analysis)

Correlation analysis for top 20 operators (T0 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering top 20 operators from the ranking list, (n=20) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for all variables

Table 15 - Correlation analysis of top 20 operators (T0 analysis)

	Revenue	Connections	ARPU
Revenue	1		
Connections	0.16	1	
ARPU	0.37	-0.60	1
Inflation	-0.29	-0.06	-0.06
Currency Dep^n	0.38	-0.43	0.43
Unemployment	0.48	0.24	0.06

A strong negative correlation is observed between connections and ARPU

growth rates. A positive correlation is observed between revenue and unemployment growth rates. Growth in currency depreciation shows a positive correlation with ARPU growth rate and a negative correlation with connections growth rate.

Correlation analysis for top 20 operators (T-1 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering top performed 20 operators from the ranking (n=20) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to 1-year post-recession figures.

Table 16 - Correlation analysis for top 20 operators (T-1 analysis)

	Revenue $t=0$	Connections $t=t-1$	ARPU $t=t-1$
Revenue $t=0$	1		
Connections $t=t-1$	0.17	1	
ARPU $t=t-1$	0.37	-0.44	1
Inflation $t=t-1$	-0.10	-0.27	0.38
Currency Dep $t=t-1$	0.19	-0.53	0.56
Unemployment $t=t-1$	0.38	0.21	0.15

A negative correlation is observed between connections and ARPU growth rates. Growth in currency depreciation shows a strong positive correlation with ARPU growth rate and a strong negative correlation with connections growth rate.

Correlation analysis for top 20 operators (T-2 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering top performed 20 operators from the ranking (n=20) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived

comparing prerecession figures to recession year figures.

Table 17 - Correlation analysis for top 20 operators (T-2) analysis

	Revenue $t=0$	Connections $t=t-2$	ARPU $t=t-2$
Revenue $t=0$	1		
Connections $t=t-2$	0.12	1	
ARPU $t=t-2$	0.38	-0.37	1
Inflation $t=t-2$	-0.13	-0.20	-0.08
Currency Dep $t=t-2$	0.25	-0.12	0.57
Unemployment $t=t-2$	0.37	-0.16	0.52

A strong positive correlation is observed between ARPU with currency depreciation and unemployment growth rates.

Correlation analysis for worst 20 operators (T0 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering worst 20 operators from the ranking list, (n=20) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for all variables.

Table 18 - Correlation analysis for worst 20 operators (T0 analysis)

	Revenue	Connections	ARPU
Revenue	1		
Connections	0.74	1	
ARPU	-0.22	-0.72	1
Inflation	-0.24	-0.41	0.37
Currency Dep	-0.14	-0.36	0.33
Unemployment	0.25	0.27	-0.19

A strong positive correlation is observed between revenue and connections growth rates, whereas a strong negative correlation is observed between connection and ARPU growth rates. Moreover, a negative correlation is observed between inflation and connections growth rates.

Correlation analysis for worst 20 operators (T-1 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering worst

performed 20 operators from the ranking (n=20) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to 1-year post-recession figures.

Table 19 - Correlation analysis for worst 20 operators (T-1 analysis)

	Revenue $t=0$	Connections $t=t-1$	ARPU $t=t-1$
Revenue $t=0$	1		
Connections $t=t-1$	0.71	1	
ARPU $t=t-1$	-0.35	-0.63	1
Inflation $t=t-1$	-0.15	-0.25	0.64
Currency Dep^n $t=t-1$	-0.17	-0.18	0.28
Unemployment $t=t-1$	0.17	0.13	-0.08

A strong positive correlation is observed between revenue and connections growth rates whereas a strong negative correlation is observed between connection and ARPU growth rates. Also, a strong positive correlation is observed between inflation and ARPU growth rates.

Correlation analysis for worst 20 operators (T-2 analysis)

Following table illustrates the results of correlation analysis between Telco and Economic KPIs considering worst performed 20 operators from the ranking (n=20) with growth rates derived comparing prerecession year figures to 2 years post-recession figures for revenue growth and other growth rates derived comparing prerecession figures to recession year figures.

Table 20 - Correlation analysis for worst 20 operators (T-2 analysis)

	Revenue $t=0$	Connections $t=t-2$	ARPU $t=t-2$
Revenue $t=0$	1		
Connections $t=t-2$	-0.15	1	
ARPU $t=t-2$	-0.45	-0.10	1
Inflation $t=t-2$	0.22	-0.16	0.34
Currency Dep^n $t=t-2$	-0.13	-0.09	-0.06
Unemployment $t=t-2$	0.23	-0.54	0.03

Table 21 - Regression statistics of top performed operators

Regression Statistics	
R Square	0.52
Standard Error	0.15
Observations	20

Table 22 - Table 18: Regression coefficients top 20 operators

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.20	0.11	1.93	0.07
Connections	0.41	0.16	2.56	0.02
ARPU	0.53	0.24	2.23	0.04
Inflation	-1.07	2.52	-0.43	0.68
Currency Dep^n	0.88	0.34	2.59	0.02
Unemployment	3.15	1.50	2.10	0.05

The P value of inflation growth figure is higher than 0.05, which emphasize the fact that it is statistically insignificant for the regression model. Based on the significance of independent variables regression analysis has been repeated to increase the goodness of fit of the model.

Equation (9)

$$R = 0.41C + 0.54A + 0.89D + 3.36U + 0.21$$

Table 24 - Modified regression coefficients for top 20 operators

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.21	0.10	2.04	0.06
Connections	0.41	0.15	2.64	0.02
ARPU	0.54	0.23	2.29	0.04
Currency Dep^n	0.89	0.33	2.73	0.02
Unemployment	3.36	1.38	2.44	0.03

Similarly, following regression model was obtained through a multiple linear regression analysis conducted for the worst 20 performed operators from the ranking list.

Equation (10)

$$R = 0.67C + 0.65A + 0.11I + 0.07D + 0.1U - 0.06$$

R - Revenue growth
C - Connection growth
A - ARPU growth
I - Inflation growth
D - Depreciation growth
U - Unemployment growth

Table 25 - Regression statistics for worst 20 operators

Regression Statistics	
R Square	0.66
Standard Error	0.06
Observations	20

Table 26 - Regression coefficients for worst 20 operators

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.06	0.07	-0.92	0.37
Connections	0.67	0.11	5.87	0.00
ARPU	0.65	0.21	3.13	0.01
Inflation	0.11	0.48	0.24	0.82
Currency Dep^n	0.07	0.13	0.58	0.57
Unemployment	0.10	0.27	0.36	0.72

The P value of inflation, currency depreciation and unemployment growth figures are higher than 0.05, which emphasize the fact that these variables are statistically insignificant for the regression model. Based on the significance of

Applicability of the case study results to current Sri Lankan economic context

Sri Lanka is currently facing an unprecedented economic crisis. Years of fiscal indiscipline and unsustainable commercial borrowing have led to unbearable level of public debt to its economy. Official reserves and net foreign assets in the banking system have been depleted, as the country continued to service debt and facilitate imports without .

independent variables regression analysis has been repeated to increase the goodness of fit of the model.

Equation (11)

$$R = 0.66C + 0.66A + 0.11I - 0.05$$

Table 27 - Improved regression statistics for worst 20 performed operators

Regression Statistics	
R Square	0.71
Standard Error	0.06
Observations	20

Table 28 - Modified regression coefficients for worst 20 operators

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.05	0.06	-0.89	0.39
Connections	0.66	0.10	6.66	0.00
ARPU	0.66	0.19	3.55	0.00

access to international financial markets which finally led to declare bankruptcy. Moreover, Sri Lanka slipped deeper in this crisis in June and July 2022 as the country's agriculture, manufac¬turing, and services sectors are constrained and drive into a catastrophic failure mainly due to shortages of imported material. Following figures further elaborates main economic KPIs reflecting status of Sri Lankan economy

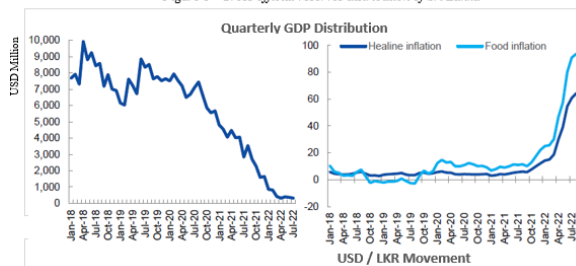*Figure 8 - Gross official reserves distribution of Sri Lanka*

Figure 7 - USD / LKR exchange rate movement (Central Bank Sri lanka, 2022)

Sri Lanka has shown negative GDP growth over last two quarters along with degradation of other economic KPIs indicated as in above figures. With reference to the definition of "Recession", it is clearly observed that Sri Lanka has entered a recession period. Hence it is vital to understand the applicability of findings of the case study to current Sri Lankan Telecommunication market.

Telco KPI behavior of mobile operators in Sri Lanka

Following figures illustrates the behavior of main telco KPIs of Sri Lankan Mobile communications industry
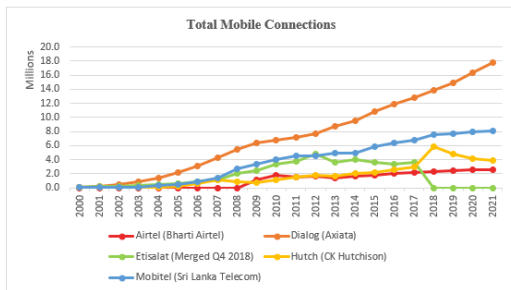
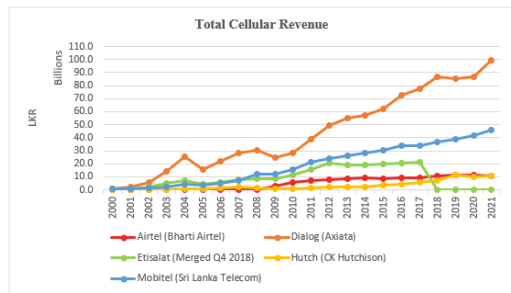*Figure 10 - Total mobile connections of operators in Sri Lanka*

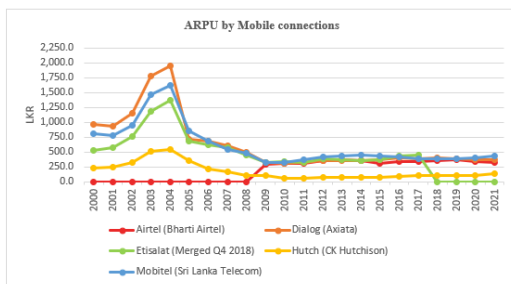*Figure 11 - Total cellular revenue of operators in Sri Lanka*

Figure 12 - ARPU by mobile connections of operators in Sri Lanka

Telecommunication sector in Sri Lanka is facing its worst economic conditions since many decades. Prevailing foreign currency deficit of the country has impacted telco operators severely due to following reasons. All telecommunication network equipment is manufactured in foreign countries and are imported on regular basis for network expansions and existing network maintenance purposes. With prevailing foreign currency deficit of the country, operators are unable to import necessary equipment for expansions and continue business operations. Hence, they are forced to find alternative strategic pathways to keep up business as usual, such as dynamically allocating underutilized existing network resources to match increasing voice and data demand.

Consumer items such as handsets, routers, dongles are not manufactured in Sri Lanka and currently imports of the said items are also on hold. Continuous availability of these consumer items is critical for expanding existing subscriber base of mobile operators. Hence operators are currently facing many obstacles in gaining new customer additions to their subscriber base.

CONCLUSION

According to results of hypothesis testing, it is observed that more than 35% of the mobile operators have faced at least a 10% revenue drop in the following year after recession and the captioned percentage increased to 40% after another year (two years from the recession). On the other hand, more than 15% mobile operators have faced a minimum of 10% connections drop in first and second years after the recession. Therefore, a similar situation can be forecasted in Sri Lanka and its mobile operators, in year 2023 and 2024 in terms of revenues and connections.

Moreover, it was concluded that more than 92% of the mobile operators failed to reach their prerecession revenue after two years from the recession year. Expecting a similar trend, Sri Lankan mobile operators are in a risk of achieving year 2021 recorded revenues till year 2024 as the best case. Correlation analysis of the results show the significant relationship between connections and revenue with r=0.52. Therefore, focusing on increasing subscriber base may help to minimize revenue losses in coming years. In addition, regression analysis showed the impact of ARPU, connections and inflation for revenue growth with the regression model **R=0.73C+0.65A -2.27I+0.01** Therefore, if inflation continues to show a growth in coming years, mobile revenues will be further adversely affected on top of forecasted revenue drops.

Furthermore, in order to mitigate revenue losses in post-recession periods, several possible actions can be taken as discussed under section "Top and worst performed operators' key actions after recession". Since there can be impediments for network expansions due to current shortage of foreign currency reserves in the country, operators shall search for new solution offerings, seek possible merges &acquisitions and but also, but not least, shall collaborate with competitors to reduce operating costs.

REFERENCES

Beers, B. (2022, 08 18). *What is Regression? Definition, Calculation, and Example. Investopedia.*

CBS News. (2011, 3 20). *CBS News. Retrieved from CBS News: https://www.cbsnews.com/news/att-to-buy-t-mobile-usa-for-39-billion/*

Central Bank Sri lanka. (2022). *GDP Growth. Retrieved from Central Bank Sri lanka: https://www.cbsl.gov.lk/en/economic-and-statistical-charts/gdp-growth-chart*

Comms Update. (2009, 10 14). *Comms Update. Retrieved from Comms Update: https://www.commsupdate.com/articles/2009/10/14/mts-completes-comstar-acquisition/*

Comms Update. (2009, 09 17). *Comms Update. Retrieved from Comms Update: https://www.commsupdate.com/articles/2009/09/17/att-buys-700mhz-spectrum-from-vulcan/*

Comms Update. (2010, 12 21). *AT&T buys Qualcomm spectrum. Retrieved from Comms Update: https://www.commsupdate.com/articles/2010/12/21/att-buys-qualcomm-spectrum/*

Comms Update. (2010, 1 3). *Comms Update. Retrieved from Comms Update: https://www.commsupdate.com/articles/2010/06/03/att-scraps-all-you-can-eat-mobile-data-plans/*

Comms Update. (2011, 06 14). *Comms Update. Retrieved from Comms Update: https://www.commsupdate.com/articles/2011/06/14/megafon-confirms-usd270-million-acquisition-of-netbynet/*

GSMA. (2022). *GSMA Intelligence. Retrieved from GSMA Intelligence: https://www.gsmaintelligence.com/*

GSMA. (2022). *The Mobile Economy Asia Pacific 2022. The Mobile Economy Asia Pacific 2022, p. 15.*

MAJASKI, C. (2021, 10 28). *Hypothesis Testing. Investopedia. Retrieved from Investopedia.*

Nickolas, S. (2021, 05 31). *Coefficients Positive, Negative, and Zero Mean? Investopedia.*

OECD. (2022). *Quarterly GDP. Retrieved from OECD Data: https://data.oecd.org/gdp/quarterly-gdp.htm*

Rodeck, D. (2022, 07 12). *What Is A Recession? Forbes Advisor.*

Staff, R. (2013, 06 26). *Vodafone to share networks in Greece with Wind Hellas. Reuters.*

Telekom Romania. (2011, 06 30). *Romtelecom is the first telecom operator to launch a GPS satellite monitoring solution. Retrieved from Telekom Romania:*

Romtelecom is the first telecom operator to launch a GPS satellite monitoring solution

The World Bank. (2022). *World Bank Open Data. Retrieved from World Bank Open Data: https://data.worldbank.org/*

Update, C. (2014, 2 25). *Telecom Italia and Enel strike deal to boost fibre-optic development. Retrieved from Comms Update: https://www.commsupdate.com/artic les/2014/02/25/telecom-italia-and-enel-strike-deal-to-boost-fibre-optic-development/*

World Bank Group. (2022). *Coping with shocks, migration and the road to resilience. South asia economic focus, p. 98.*